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ORIGINAL RESEARCH

Evaluation of Changes in Dental Arch Width Induced by Removable Appliances over a 10-Month Period in Children with Malocclusion

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ABSTRACT
Background: To evaluate changes in dental arch width induced by removable appliances in children with malocclusion. **Materials & Methods:** A total of 10 subjects were enrolled. The mean age was 10.55 years and with 6 girls and 4 boys. They were divided into 2 groups as study group and control group with 5 in each. The study group subjects were found with removable appliances within the upper dental arch for a period of 10 month and the control group did not require any treatment in the upper dental arch. Chi squared test was done. The level of statistical significance was set at $p \leq 0.05$. **Results:** No significant differences in age were observed between the groups (mean age 11.05 in the study group and mean age 10.18 in the control group). However, there were statistically significant distinctions between the groups in the B to A parameter ratio during the initial measurement (MT = 1.1 vs. MC = 1.0, $p < 0.001$). **Conclusion:** The utilization of removable appliances in children with reduced maxillary transverse dimension helps counterbalance growth variations when compared to children exhibiting normal occlusion.
Keywords: malocclusion, dental arch, maxillary.

INTRODUCTION

Growth and development of the dental arch are considered continuous and complex biological processes. It includes three-dimensional changes in width, length and height of the arch. These changes vary with age in measurements of each parameter and magnitude of change through each stage of growth and development. [1] The changes in facial dimensions occur in vertical and sagittal dimensions throughout growth of children. During transition from primary to mixed then to permanent dentition, dental arch form and width vary due to tooth movement and vertical growth of alveolar process. [2] The occlusion and dental arches change dynamically throughout the human lifespan. Dental arches develop and expand from childhood to adolescence, along with craniofacial growth, dentoalveolar growth, and eruption of primary and permanent teeth. Transversal growth of the dental arches is finished before 15 years of age. [3] Maxillary dental arch length increases until 10 years of age and mandibular dental arch until 7 years of age in girls and 10 years of age in boys. [4] Later, after adolescence, dental arch dimensions decrease slightly as part of natural dentoalveolar changes in normal occlusion. Dental arch width is known to be more stable after growth than dental arch length. [4]
Removable appliances are widely used in the treatment of malocclusions. It has been shown that they improve dental and skeletal treatment outcomes.[5]Fränkel emphasized the importance of soft tissue impact, pointing out that abnormal craniofacial muscle tone plays a key role in the development of skeletal and alveolar defects. With removable appliances, it is possible to widen the maxilla at the base of the alveolar process even after the eruption of permanent premolars.[5] All removable appliances influence the base of the maxilla and the mandible, but the way this is achieved differs depending on the type of appliance.[6]
The shape and size of the dental arches are of particular interest to orthodontists because their assessment influences the planning of orthodontic treatment.[7,8] During diagnostics and planning orthodontic treatment, it is very important to accurately assess the transverse relationship of both dental arches. This is important because orthodontic treatment aims to achieve an optimal transverse relationship between the maxilla and the mandible.[9] It

is assumed that the dental arch is shaped and limited by bone systems, and is influenced by the eruption of the teeth and the surrounding muscles.[10] The effectiveness of orthodontic treatment depends on maintaining the shape of the dental arch; therefore, the dimensions of the dental arches are important values that should be assessed.[10] Hence, this study was conducted to evaluate changes in dental arch width induced by removable appliances in children with malocclusion.

MATERIALS & METHODS

A total of 10 subjects were enrolled. The mean age was 10.55 years and with 6 girls and 4 boys. They were divided into 2 groups as study group and control group with 5 in each. The study group subjects were found with removable appliances within the upper dental arch for a period of 10 month and the control group did not require any treatment in the upper dental arch. The dimensions were measured and further divided into A, B, C and D. Initially, the posterior width of the upper dental arch was measured, followed by the measurement of the anterior width of the upper dental arch, and subsequently, the ratio between these widths was computed. A panoramic radiographs were taken. The results were analysed using SPSS software. Chi squared test was done. The level of statistical significance was set at $p \leq 0.05$.

RESULTS

No significant differences in age were observed between the groups (mean age 11.05 in the study group and mean age 10.18 in the control group). However, there were statistically significant distinctions between the groups in the B to A parameter ratio during the initial measurement (MT = 1.1 vs. MC = 1.0, $p < 0.001$). The Pearson correlation analysis revealed a statistically significant positive correlation between the age of the examined children in the control group and parameter A. However, there were no significant correlations between age and mandible parameters in children with malocclusion undergoing appliance treatment.

Table 1: Variables

Variable	Study group Mean	Control group Mean	P value
Age (years)	11.05	10.18	0.2
B/A	1.1	1.0	0.001*

*: statistically significant, B/A: the posterior width of the upper dental arch was measured, followed by the measurement of the anterior width of the upper dental arch, and subsequently, the ratio between these widths.

Table 2: correlation between age and maxilla and mandible parameters

Study group	Mean (mm)	P- value
A	30.65	0.3
B	34.89	0.3
C	25.54	0.5
D	45.12	0.2
Control group	Mean (mm)	P –value
A	33.72	0.001*
B	35.84	0.001*
C	26.67	0.2
D	45.83	0.7

*: statistically significant, Dimension A refers to the anterior width of the upper dental arch, dimension B signifies the posterior width of the upper dental arch, dimension C represents the anterior width of the lower dental arch, and dimension D corresponds to the posterior width of the lower dental arch.

DISCUSSION

Guiding anterior crossbite to a normal position is one of the most important responsibilities of a pediatric dentist or orthodontist to gain both esthetic and function. [11] American Association of Orthodontist defines crossbite as: An abnormal relationship of tooth or teeth to the opposing tooth or teeth in which normal buccolingual or labiolingual relationships are reversed. [12] Prevalence of anterior crossbite which becomes evident during the mixed dentition has been reported from 4.5 to 9.5%. [13,14] Hence, this study was conducted to evaluate changes in dental arch width induced by removable appliances in children with malocclusion.

In the present study, no significant differences in age were observed between the groups (mean age 11.05 in the study group and mean age 10.18 in the control group). However, there were statistically significant distinctions between the groups in the B to A parameter ratio during the initial measurement (MT = 1.1 vs. MC = 1.0, $p < 0.001$). A study by Palka J et al, evaluated the impact of removable appliances used over a 10-month period on growth changes in children with narrowed jaw dimensions. Twenty four patients were included in the study (a study group—patients, treated with removable appliances in the upper dental arch for a minimum of 10 months; a control group—patients with no craniofacial abnormalities and who did not require orthodontic treatment). A panoramic radiograph and digital intraoral scan were taken, followed by palatal width measurements in Ortho-CAD before treatment, and after a period of 10 months of treatment with removable appliances. After a period of 10 months of the treatment, the study group had a statistically significantly greater mean change in the anterior width of the upper dental arch than the control group. The use of removable appliances in children with narrowed maxillary transverse dimension contributes to offsetting growth changes in comparison to children with normal occlusion.[15]

In the present study, the Pearson correlation analysis revealed a statistically significant positive correlation between the age of the examined children in the control group and parameter A. However, there were no significant correlations between age and mandible parameters in children with malocclusion undergoing appliance treatment. Another study by Zhang Y et al, subject children aged 6–10 years with a maxillary transverse deficiency received ERME treatment, cone-beam computed tomography (CBCT) and lateral cephalometric radiographs were measured before and after treatment, and statistical differences in the measured items were evaluated with corresponding statistical methods to explore the skeletal and dental changes. After ERME treatment, there was a statistical increase in the maxillary basal bone arch width, nasal cavity width, maxillary alveolar bone arch width, and maxillary dental arch width. A buccal inclination of the maxillary alveolar bone and a buccal inclination and buccal movement in the alveolar bone of maxillary first molars were found. The maxillary skeletal expansion was statistically greater than the dental expansion. Increases in the mandibular alveolar bone arch width and dental arch width happened after treatment. A decrease in angle ANB and an increase in Ptm-A, U1-SN, U1-PP, L1-MP, and L6-MP were found after treatment. No statistical changes in the growth pattern-related measured items were observed. ERME could expand the maxillary basal bone arch width, nasal cavity width, maxillary alveolar bone arch width, and maxillary dental arch width. The maxillary skeletal expansion was greater than the dental expansion. Secondary increases in the mandibular alveolar bone and dental arch widths would happen after ERME. ERME would result in a mandibular advancement, a labial inclination of maxillary anterior teeth, and an increase of maxillary sagittal length, and would not change the patient’s growth pattern. [16] Maxillary transverse deficiency is a common developmental deficiency in oral examination, of which the etiology is complicated and is related to genetic and environmental factors, including congenital abnormalities, cheek sucking habit, mouth breathing, low tongue position, etc. [17] Posterior crossbite is one of the most easily discernible clinical symptoms of maxillary transverse deficiency, among which unilateral posterior crossbite may result in an increased frequency of reverse chewing cycles and a decreased masticatory efficiency and further causes abnormal facial form and muscle function and asymmetrical mandibular development. [18,19] Maxillary transverse deficiency may lead to anterior crossbite and maxillary dentition crowding.[18] In addition, maxillary transverse deficiency is related to the occurrence of some sagittal malocclusions and may affect the dental and maxillofacial growth in the opposite direction because the sagittal and vertical growth continues after the completion of transverse growth.[20] Among the six elements of orofacial harmony proposed by Andrews, "ideal dental arch morphology" is a key element. [21] The use of digital intraoral scanners in orthodontics allows measurements to be made on virtual casts, which contributes to greater accuracy and reliability of the studies performed. The use of virtual casts combined with specialized software allows clinicians to make measurements that were once impossible to analyze and facilitate analysis of cases that caused difficulty when using traditional tools. [22] Defining a reliable and reproducible reference plane has been discussed in many articles in the field of dentistry. [22,23] However, it is still one of the problems faced by clinicians to define a single reference method for measuring the width of dental arches, as well as to find the optimal measurement method to be the reference during growth. [22] In a study, Kim et al. verified that palatal margin lines are stable reference points during patient growth. [22,24] To identify patients with maxillary constriction (transverse hypoplasia of the maxilla), the following method is used: transpalatal tooth-to-tooth measurement between individual teeth. Arch width is one of the parameters that influences the resulting arch shape and plays a key role in creating an optimal occlusion. In their study, Banker et al found that in the majority of the normal maxillary arches, in the sagittal projection, the cusp tip of the canine was usually in line with the palatal surface of the first molar. They hypothesized that the interpalatal molar width (IPMW), the intercanine width (ICW), and their ratio can determine the transverse dimension of the maxilla. Given this, they made an attempt to quantify the arch form using this ratio. The intercanine width was measured between the tips (cusps) of the right and left canines in the maxilla. When the canines were outside the arc, measurements were taken from the arc line. The interpalatal molar width was measured at the point of contact of the palatal sulcus with the gingival margin of the first molar on the left and the former side. The measurement was additionally supported by all four upper incisors. [25]

CONCLUSION

The utilization of removable appliances in children with reduced maxillary transverse dimension helps counterbalance growth variations when compared to children exhibiting normal occlusion.

REFERENCES

1. Yang D, Liang S, Zhang K, Gao W, Bai Y (2019) Evaluation of growth and development of late mixed dentition upper dental arch with normal occlusion using 3-dimensional digital models. J Healthc Eng. 2019:4191848.
2. Slaj M, Jezina MA, Lauc T, Rajić-Mestrović S, Miksić M (2003) Longitudinal dental arch changes in the mixed dentition. Angle Orthod. 73(5):509–14.
3. Heikinheimo K, Nyström M, Heikinheimo T et al. . Dental arch width, overbite, and overjet in a Finnish population with normal occlusion between the ages of 7 and 32 years. Eur J Orthod 2012;34:418–26.
4. Thilander B. Dentoalveolar development in subjects with normal occlusion. A longitudinal study between the ages of 5 and 31 years. Eur J Orthod 2009;31:109–20.
5. Kilic N., Celikoglu M., Oktay H. Effects of the functional regulator III on transversal changes: A postero-anterior cephalometric and model study. Eur. J. Orthod. 2011;33:727–731.
6. DiBiase A.T., Lucchesi L., Qureshi U., Lee R.T. Post-treatment cephalometric changes in adolescent patients with Class II malocclusion treated using two different functional appliance systems for an extended time period: A randomized clinical trial. Eur. J. Orthod. 2020;42:135–143.
7. Ling J.Y.K., Wong R.W.K. Dental Arch Widths of Southern Chinese. Angle. Orthod. 2009;79:54–63.
8. Banker A.M., Pillai J.P., Patel K.D. Determination of normal maxillary transverse dimension by using intercanine width and interpalatal first molar width. Indian. J. Dent. Res. 2016;27:468–472.
9. Batwa W., Baeshen H.A. Use of Interarch Width Ratio to measure Transverse Relationship: A New Method to measure and assess Interarch Discrepancy. J. Contemp. Dent. Pract. 2018;19:515–520.
10. Omar H., Alhajrasi M., Felemban N., Hassan A. Dental arch dimensions, form and tooth size ratio among a Saudi sample. Saudi. Med. J. 2018;39:86–91.
11. Al-Sehaibany F, White G. A three dimensional clinical approach for anterior crossbite treatment in early mixed dentition using an ultrablock appliance: case report. J Clin Pediatr Dent. 1998;23(1):1–7.
12. American Association of Orthodontists. 2012. https://www.aaoinfo.org/system/files/media/documents/2012AAOGlossary_0.doc
13. Shalish M, Gal A, Brin I, et al. Prevalence of dental features that indicate a need for early orthodontic treatment. Eur J Orthod. 2013;35(4):454–459.
14. Reddy ER, Manjula M, Sreelakshmi N, et al. Prevalence of malocclusion among 6 to 10 year old Nalgonda school children. J Int Oral Health. 2013;5(6):49–54.
15. Pałka J, Gawda J, Byś A, Zawadka M, Gawda P. Assessment of Growth Changes in the Width of Dental Arches Caused by Removable Appliances over a Period of 10 Months in Children with Malocclusion. Int J Environ Res Public Health. 2022 Mar 15;19(6):3442.
16. Zhang, Y., Yang, J. & Li, X. Assessment of early dental arch growth modification with removable maxillary expansion by cone-beam computed tomography and lateral cephalometric radiographs: a retrospective study. BMC Oral Health 23, 727 (2023).
17. Luzzi V, Ierardo G, Viscogliosi A, Fabbrizi M, Consoli G, Vozza I, Vestri A, Polimeni A. Allergic rhinitis as a possible risk factor for malocclusion: a case-control study in children. Int J Paediatr Dent. 2013;23(4):274–8.
18. McNamara JA. Maxillary transverse deficiency. Am J Orthod Dentofacial Orthop. 2000;117(5):567–70.
19. Piancino MG, Isola G, Merlo A, Dalessandri D, Debernardi C, Bracco P. Chewing pattern and muscular activation in open bite patients. J ElectromyogrKinesiol. 2012;22(2):273–9.
20. Cortella S, Shofer FS, Ghafari J. Transverse development of the jaws: norms for the posteroanterior cephalometric analysis. Am J Orthod Dentofacial Orthop. 1997;112(5):519–22.
21. Kurihara S, Enlow DH, Rangel RD. Remodeling reversals in anterior parts of the human mandible and maxilla. Angle Orthod. 1980;50(2):98–106.
22. Ahn J.-S., Park M.-S., Cha H.-S., Song H.C., Park Y.-S. Three-dimensional interpretation of intercanine width change in children: A 9-year longitudinal study. Am. J. Orthod. Dentofac. Orthop. 2012;142:323–332.
23. Benazzi S., Fantini M., De Crescenzio F., Persiani F., Gruppioni G. Improving the spatial orientation of human teeth using a virtual 3D approach. *J. Hum. Evol.* 2009;**56**:286–293.
24. Kim H.-K., Moon S.-C., Lee S.-J., Park Y.-S. Three-dimensional biometric study of palatine rugae in children with a mixed-model analysis: A 9-year longitudinal study. *Am. J. Orthod. Dentofac. Orthop.* 2012;**141**:590–597.
25. Banker A.M., Pillai J.P., Patel K.D. Determination of normal maxillary transverse dimension by using intercanine width and interpalatal first molar width. Indian. J. Dent. Res. 2016;27:468–472.